The paradox of using residual feed intake or conversion ratios to study feed efficiency in dairy ewe

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Feed efficiency in dairy ruminants is a complex trait that has traditionally been estimated through feed conversion ratios (e.g. the ratio between the amount of feed consumed and the energy corrected milk production – FCR). More recently, the residual feed intake (RFI) is being increasingly used. This index is calculated as the difference between actual feed intake and predicted feed requirements for maintenance and milk production: the lower the RFI, the higher the feed efficiency. Both metrics, FCR and RFI, have been widely used in feed efficiency investigations. However, they probably reflect different mechanisms, which might lead to confusion or apparent contradictions. Therefore, this preliminary work was conducted to compare both indexes in a study carried out with 40 Assaf ewes with the aim of selecting the 20% most efficient and inefficient animals to investigate then the mechanisms underlying the animal-to-animal response. Data of daily intake, milk production, milk fat, protein and lactose, and live weight were collected individually to calculate RFI and FCR. Values of RFI ranged from -0.80 to 0.71 (on average, -0.02±0.063) and those of FCR from 0.61 to 1.52 (on average, 0.93±0.031). Unexpectedly, only 4 out of the 8 ewes classified as the most inefficient according to RFI were also within the 20% most inefficient animals when estimated with FCR. This behaviour was even worse when analysing the most efficient sheep: only 1 out of the 8 animals selected with RFI were confirmed with FCR. In addition, another 2 from the most efficient group according to RFI belonged to the most inefficient when classified by FCR. Only a poor, although significant, linear relationship (R^2=0.355; P<0.01) was found between both indices. The FCR is nowadays under question due to its correlation with animal size and performance, but still in use. However, many scientists, particularly geneticists, recommend RFI. The poor correlation between them would draw attention to and caution about paradoxical results when either RFI or FCR are utilised to estimate feed efficiency. Acknowledgements: Project CSI276P18, JCyL, FEDER and ESF, UE.

Ruminal biohydrogenation of dietary lipids in dairy sheep that differ in feed efficiency

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It is widely accepted that improving ruminant production requires an enhancement of feed efficiency (FE). However, mechanisms underlying this trait and explaining its large individual variation are still unknown. Some studies have examined the potential link between FE and ruminal microbiota, with certain bacterial populations being more or less abundant in more or less efficient animals. In addition, some of these bacteria might play a role in the biohydrogenation (BH) of dietary lipids and produce bioactive intermediates, which could perhaps be related to FE. To examine this potential relationship, the FE was estimated in 40 lactating Assaf ewes through the residual feed intake to identify the most (n=8) and least (n=8) efficient animals. Rumen samples were collected with a stomach tube and analysed for fatty acid (FA) composition by gas chromatography. An ANOVA was performed to compare the response in both groups of sheep. Results showed a greater proportion of unsaturated fatty acids (UFA) of dietary origin and of several BH intermediates (e.g. cis-9 cis-12 18:2, trans-9 cis-12 18:2, cis-9 18:1; P<0.10) in the rumen of less efficient animals. In contrast, an increase of stearic acid (18:0; P<0.05) was observed in more efficient sheep, supporting a larger extent of the BH process. Variations in certain odd-chain FA were also found: the content of 17:0 was higher in the most efficient ewes, while that of 13:0 was higher in the least efficient (P<0.10). Although these FA are synthesised de novo by ruminal bacteria, available information is too scarce to use them as indicators of changes in specific biohydrogenating groups. In summary, our results show differences in the ruminal BH pattern in dairy ewes that differ in FE, with lower UFA, and greater 17:0 and 18:0 concentrations in the most efficient animals. Further research is needed to understand the role of the rumen microbiota, particularly that involved in BH, and its potential link with feed efficiency [Acknowledgements: Project CSI276P18, JCyL, FEDER and ESF, UE].

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INTRODUCTION

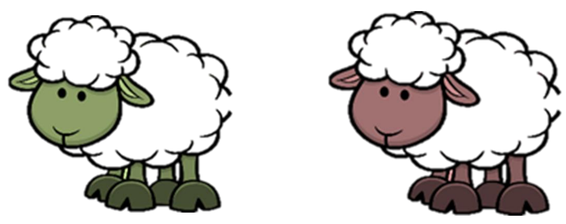
Feed efficiency (**FE**) in dairy ruminants is a complex trait traditionally estimated through feed conversion ratios (**FCR**). However, the residual feed intake (**RFI**) is being increasingly used.

Both metrics, FCR and RFI, have been widely used in feed efficiency investigations, but they probably reflect different mechanisms, which might lead to confusion or apparent contradictions.

AIM: to compare both indexes in a preliminary study carried out with 40 Assaf ewes to select the most efficient and inefficient animals in order to be able to investigate the mechanisms underlying the animal-to-animal response.

MATERIAL AND METHODS

Total animals = 40



High-FE n=8 **Low-FE** n=8

Experimental conditions: (3 weeks)
- TMR (50:50 F:C)
- Ewes allocated in individual tie stalls
- 2 milkings/day

- Data of daily DM intake and milk yield were collected individually to estimate **feed efficiency** through **RFI** and **FCR**.
- **RFI** calculated as the residual term from the regression of actual DM intake on milk yield, energy value of milk, metabolic body weight, energy value of tissue gained or lost over the experimental period, and parity.
- **FCR** calculated as: ratio between DM intake and energy corrected milk -ECM- (estimated based on NRC recommendations; 2001).

RESULTS

* Sorting criteria

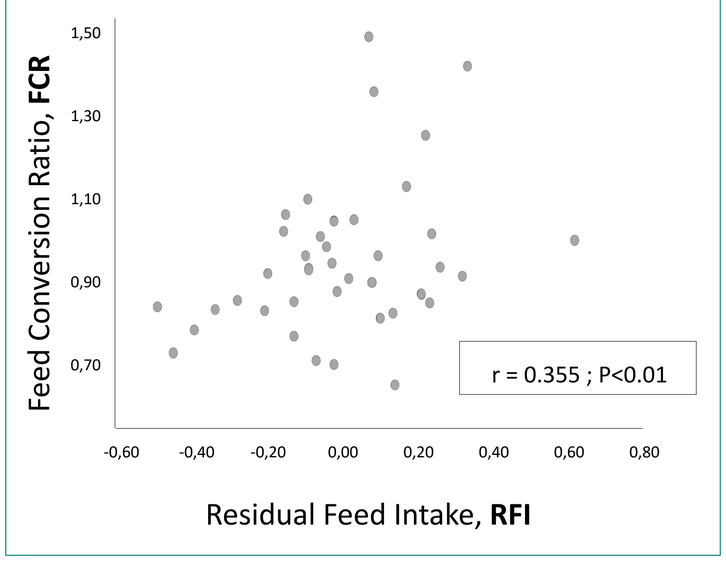
Animal	FCR	RFI *
# 17	0,81	-0,49
# 13	0,69	-0,44
# 7	0,75	-0,39
# 33	0,81	-0,33
# 32	0,83	-0,27
# 28	0,80	-0,20
#34	0,90	-0,19
# 27	1,01	-0,15
# 39	1,05	-0,15
# 30	0,74	-0,12
# 24	0,83	-0,12
# 18	0,95	-0,09
# 4	1,09	-0,09
# 26	0,91	-0,08
# 2	0,91	-0,08
# 14	0,67	-0,06
# 35	1,00	-0,05
# 20	0,97	-0,04
# 29	0,93	-0,02
# 1	0,66	-0,02
# 3	1,04	-0,02
# 40	0,85	-0,01
# 25	0,89	0,02
# 11	1,04	0,04
# 19	1,52	0,08
# 10	0,88	0,08
# 5	1,38	0,09
# 37	0,95	0,10
# 12	0,78	0,11
# 6	0,80	0,14
# 21	0,61	0,15
# 31	1,13	0,17
# 36	0,85	0,21
# 15	1,26	0,23
# 9	0,82	0,24
# 8	1,01	0,24
# 16	0,92	0,26
# 38	0,89	0,32
# 22	1,44	0,34
# 23	0,99	0,62

RFI → values between -0.49 and 0.62 (on average 0 ± 0.035);

FCR → values between 0.61 to 1.52 (on average, 0.93 ± 0.031).

1) **High-FE**: only 2 out of 8 animals selected with RFI were confirmed with FCR

2) **Low-FE**: only 2 out of 8 animals selected with RFI were confirmed with FCR;



CONCLUSIONS

The poor relationship between RFI and FCR would draw attention to and caution about paradoxical results when these indexes are utilized to estimate feed efficiency.

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